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ABSTRACT

Today university students are demanding a greater say in their tertiary education. In particular they are demanding a greater flexibility in the way they receive their instruction, and it is imperative that course delivery strategies that fulfil these expectations are investigated. On-line delivery of learning materials offers teacher and students a more flexible mode that may better suit the learning style and commitments of many of the students. During the last decade, the teaching of students in first year biology at the University of Sydney has changed from a teacher-centered focus to a student-centered focus and part of the strategy has been to create a Virtual Learning Environment (VLE) on the Web to encourage independence and increased flexibility of access. The paper shows how the learning experiences of these students have been influenced by a change in teaching philosophy and how this change has stimulated the development of a learning environment which offers both individual learning experiences and opportunities to work together. (Contains 19 references.) (Author/YDS)

From Informational Technology in biology teaching to Inspirational Technology: Where have we come from and where are we going?

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"Information Technology includes the systematic applications of computing, telecommunication, media and other electronic technologies to the collection, processing, transformation, organisation, storage, transfer and presentation of information in all its forms in order to enhance the performance of individuals and organisations in a wide range of activities" (CAUDIT, 1995).

Today university students are demanding a greater say in their tertiary education. In particular they are demanding a greater flexibility in the way they receive their instruction, and it is imperative that we investigate and experiment with course delivery strategies that fulfil these expectations. On-line delivery of learning materials offers teacher and students a more flexible mode that may better suit the learning style and commitments of many of the students.

During the last decade the teaching of students in first year biology at The University of Sydney has changed from a teacher-centred focus to a student-centred focus and part of the strategy has been to create a Virtual Learning Environment (VLE) on the Web to encourage independence and increased flexibility of access. The paper will show how the learning experiences of these students have been influenced by a change in teaching philosophy and how this change has stimulated the development of a learning environment which offers both individual learning experiences and opportunities to work together.

Introduction

Clearly computers, television, literature databases, and audiovisual materials have been available for years. So what is different about today's high-tech learning environment? Several factors have developed simultaneously to change the potential of IT as a learning tool. The most important is the ubiquity of computer networks which has opened up the world. Additionally, a convergence in digital technology has provided user-friendly multimedia instructional platforms; the emergence of a cognitive learning theory which emphasises inquiry; and a marked change in the needs of society which has had an impact on the education process. In particular we need to encourage the work force of tomorrow to have the skills of abstraction, system thinking, experimentation and collaboration (Awbrey, 1996).

The potential uses of IT in information storage, delivery and creating challenges in teaching biology are undeniably great. IT provides greater educational flexibility by creating learning environments that are accessible to individuals with a variety of learning styles. Technology can assist in overcoming barriers faced by students of all descriptions (distant, impaired, etc.). However with all this technology we are still not filling our biology curricula with meaningful IT

experiences (most student computer access laboratories at universities are used almost exclusively for word processing). In schools, computer laboratories are more frequently used by disciplines other than science. Traditionally the actual use of IT in biology teaching in the higher education sector was relatively low (Chambers *et al.*, 1995, using 1994 data). Although computer use in universities increased dramatically in the following two years (Johnston, 1996), there are barriers still in place that inhibit the development of curricula that embrace the inclusion of IT. For effective integrated use of IT there need to be associated outcomes defined (for example, all students will graduate knowing how to locate and evaluate educational resources). At the secondary level this has been recognised and acknowledged by the Board of Studies (Staples, 1996). However, a limitation to the adoption of IT in teaching in schools is the lack of knowledge about what resources are available and how to use them. In addition, schools often lack a coordinated system of support for the implementation of technology. To obtain the full benefits of the potential of IT, we need to recognise a whole-school approach in which all teachers in the school work together to ensure success.

How do we use computers to help students learn?

At the 1994 National Teaching Workshop Elaine Martin reflected on the offerings of the workshop and came up with a synopsis which is still relevant today (Martin, 1994). Computers are used

1. as an information resource. Computers can store infinite amounts of information which can be easily accessed and supported with sound and animation. This is a valuable basic tool.
2. to test and drill students in systematic and insistent ways. This can both free up teacher time and give students flexibility to work at times convenient to them. However, caution should be exercised as many drill and practice tests can be surface, superficial learning experiences.
3. as model makers. Students can be encouraged to make better sense of the world by modelling some aspect of it through interaction with a package, such as *Investigating Lake Iluka* which is a good example of contextual teaching using a computer. The most effective of these examples are those that encourage exploration and empowerment rather than prescription and control. They enable the teacher to move from being "a sage on the stage to a guide at the side".

In the 1996 survey of the use of IT in science teaching, UniServe Science (Johnston, 1996) found that the main modes of use could be classified as: pedagogical mode (CAL packages and the like); expository mode (teaching aides e.g. simulations during lectures, PowerPoint presentations); and apprentice mode (students learning to use the computer to develop professional skills). UniServe Science is concerned that pedagogical progress is not being made with regard to the use of technology in education. As new technologies emerge it appears that current development of IT-based educational resources is being done by technocrats who are not taking advantage of the lessons learned in the early '90s with regard to the design of effective teaching materials. For example, the people writing Java applets are often not experienced CAL developers, and they are not incorporating the accepted educational standards for screen design, graphics and text presentation. Thus the same mistakes are being made all over again, this time on the Web rather than on the stand-alone PC or Mac.

With respect to the use of computers in teaching, the Open University (UK) emphasises that all technology-based activities should have a clearly defined

purpose, address student needs and be accompanied by some form of teacher guidance (Laurillard, 1994).

Recent studies on the level of IT skills of incoming university students highlight a need for developing an improved IT skill-base (comparable to that developed in sport or community activity) that will support life-long learning. Perceptions of school-leavers towards IT skills indicate that they are not getting them at school even though they believe they need them for employment and they believe (along with their teachers) that the school has a responsibility to provide the opportunity to develop the skill-base (Oliver, 1993).

Recent activity in the Asia-Pacific region reflects the push seen in other parts of the world in the introduction of stable, well-supported IT systems for educational purposes. Looi (2001) reports high levels of activity in the provision of IT facilities, in the ongoing technical support, in the training of teaching staff and in the interactions between university research academics and school teachers that are enhancing the learning outcomes of students. In Taiwan, for example, the Ministry of Education has established IT resource centres to develop subject-based networked resources for teachers in the primary and secondary sectors. Similarly UniServe Science has provided teacher resources to support the new HSC science syllabuses (http://science.uniserve.edu.au/school/) and the delivery of these resources online makes them accessible to all.

So - how are we using computers in our tertiary teaching?

In a previous paper given at the 1997 Board of Studies two-day planning workshop for the new HSC science syllabuses, we argued for care to be taken when implementing any IT in teaching and to remember the need to integrate it into the curriculum (Peat & Fernandez, 1998). In that paper we identified the following uses of IT in teaching and learning and gave descriptions and examples of each.

- CAL packages as tutorial or revision material or recreating authentic experiences
- Students creating their own CAL as a learning experience
- Video conferencing for local and global communications
- Presentation tools for teachers and students
- Assessment, both formative and summative
- Distance education, delivery 'any time, any place'
- Generic uses of the Internet – Email, Newsgroups, Discussion groups and web-based resources (e.g. electronic journals)
- Specific teaching and learning applications of the Internet – Telecollaborative projects, Virtual Field Trips, HSC On-Line (http://hsc.csu.edu.au/)

Many of these uses are still applicable today, however, the rapid uptake of the Web as a means of dissemination and communication has altered their look and feel.

A mix of learning opportunities

At The University of Sydney in the School of Biological Sciences we have been using IT in our teaching since 1992. More recently we have developed a Virtual Learning Environment (VLE) on the Web for our first year students.

For more than ten years we have been modifying our teaching and learning philosophy from teaching students to facilitating student learning, especially within the laboratory experience. Early changes involved organisational and structural issues, such as the way the laboratory classes were designed or reviewing which activities best suited a student-centred learning approach. Teaching methodologies and scenarios have been put in place that emphasise small group teaching and

student-centred learning, and facilitate the development of learning communities in class, all of which encourage peer-assisted learning, communication skills and socialisation of the students (Franklin & Peat, 1996). Delivering learning materials on computer, firstly within the laboratory class and then on the Internet, improved student access to the learning opportunities. With the development of a virtual learning environment on the Web we are now in a position to exploit best practice in web-based delivery.

On-campus

Our courses are still campus-based and students attend lectures and laboratory sessions in most weeks of the semester. There is a slight trend towards a reduction in the number of face-to-face lectures (in one course independent study modules replace a third of the lectures) but in the light of strong departmental opposition to reducing the number of on-campus lectures, this is a slow process. Laboratory sessions are a feature of experimental science disciplines and at present these are being retained. The introduction of computers in 1994 as a permanent feature in the laboratory and the development of computer-assisted learning modules (CAL) to target specific learning difficulties led to a focus on the use of computers in the learning process. This in turn led to the development of an on-line resources room (Franklin & Peat, 1998), which has now been re-purposed to provide a complete learning environment on-line.

On-line

Since the early 1990s the use of computers in education has led to an explosion of material and delivery modes for teaching, learning, and assessment tasks. As a result of this we were able to offer the students a variety of computer-based materials in our units of study, which, with the development of the Internet, were put on-line. Our materials are used for a variety of teaching and learning scenarios: modules to be completed pre-lecture and pre-practical class; modules available within the practical class; and modules enabling revision, and self-assessment. These have been described and evaluated elsewhere (Peat, 1999; 2000; Peat, Franklin & Mackay-Wood, 1997). Students are directed to particular modules at given times and many are accompanied by paper-based resources. It is recognised that the incorporation of information technology can change the role of students and teachers, facilitate more student-centred learning and expand the scope and content of the curriculum. Given the current environment, the learning paradigm is one where students are provided with a range of resources to cover the curriculum of the course and this range has been designed to cater for a variety of learning styles (Franklin & Peat, 2001). The development of a virtual learning environment enabled us to deliver all these materials in an integrated way to the students.

The Virtual Learning Environment

The design of the VLE uses a building metaphor, the building representing the School of Biological Sciences. The students enter the Lobby of Level 1 (representing first year studies) and are presented with access to general materials and help functions. Figure 1 shows the layout of the lobby (http://fybio.bio.usyd.edu.au/vle/L1/). From the lobby the building metaphor is continued enabling students to enter various rooms, each of which represents a course in first year biology, the Resource Centre (parts of the original on-line

resources room) or other areas within the University, such as the University Library.

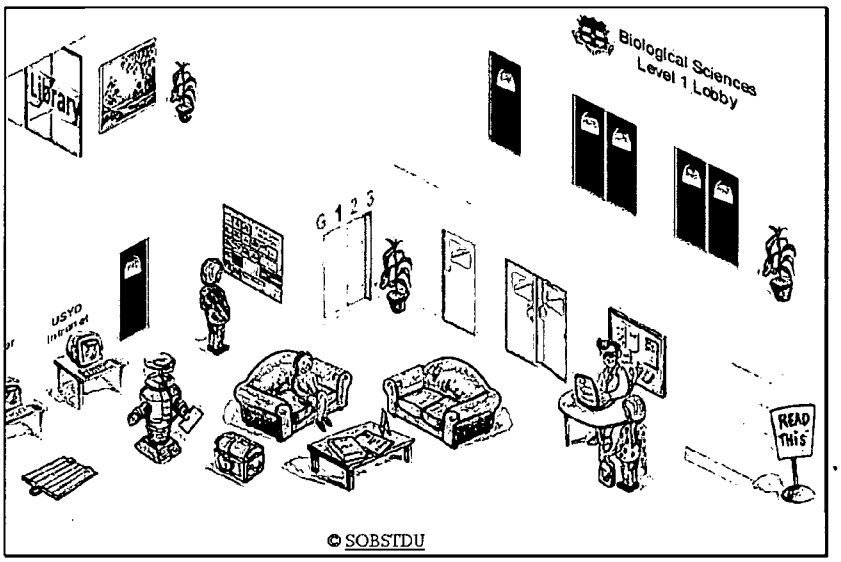

Figure 1. First Year Biology Lobby

Within the lobby there is a notice board with the names and email addresses of staff, a coffee table with general information, and access to CyberAdmin and CyberTech, for answers to general questions of an administrative or technical nature. Importantly the lobby has doors opening into the separate units of study, with semester 1 units being on the same level as the lobby and the semester 2 units on the mezzanine floor. The Resource Centre contains all the computer-based learning resources for all the units of study. All the icons/objects in the lobby and the course rooms have "mouse over" pop-up labels to assist with navigation.

The lobby leads students through a door into a course. Once inside a course room (see Figure 2) there are resources available that are appropriate for the unit and exits to areas such as the University Library and the Lobby, and doorways to the lecture theatres (lecture notes) and a seminar room (web-based discussions). On the wall a notice board provides current information concerning that course. CyberTutor appears here and is available to discuss biological content, while CyberAdmin and CyberTech are also available in the course room. The development of CyberTutor was discussed previously (Franklin & Peat, 1998) and whilst Barnes (1999) emphasises the need for students to remain anonymous when communicating electronically with staff, we have not found that this lack of anonymity deters the students from contacting us: in fact the opposite may be true. Learning materials are available from computer icons (tutorials, revision modules, remedial materials and self-assessment modules) and there is a desk where students can access tests and examinations (answers to weekly self-test questions from the laboratory notes and to a mid course examination and sample examination questions). In this way the students are encouraged to focus their attention on the materials, communication functions, and discussion forums that are available for the specific course without being presented with all the materials available in the Resource Centre.

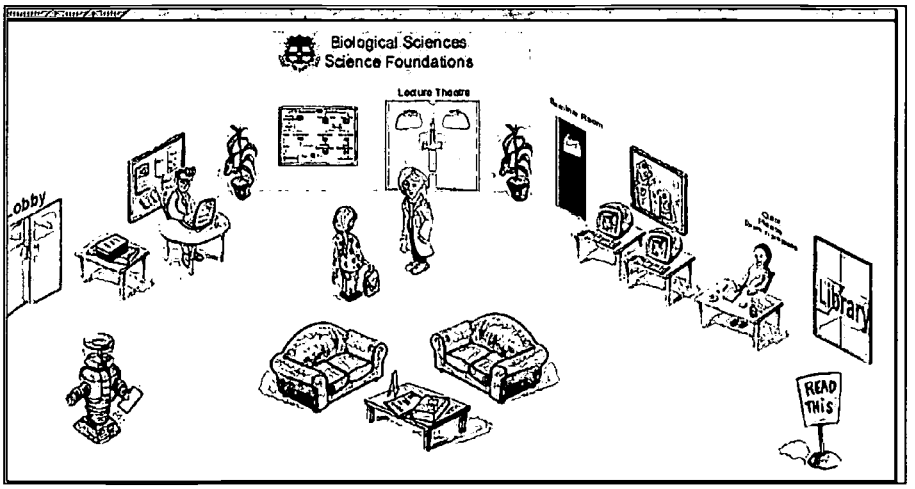

Figure 2. Course Room

A peer discussion forum, specific to the course, encourages students to access each other in real or virtual time, although it is best used asynchronously. It allows students to post questions or discuss any topic with their peers. A general biology discussion forum is also available via the lobby. Student use of this facility was slow initially but has increased as more students obtain better access to the Internet and their skills in using these facilities improve. Discussion topics include: examinations; lectures; laboratory reports; ethics of using animal materials; posters; lecture theatres; how to reference URLs; and technical help with downloading materials. Staff-mediated discussions are currently being trialed using WebTeach and have proved to be most successful, especially during periods of report writing and examination preparation.

External peer reviews of the biology learning environment have been very positive (Jones, 1999; Fyfe, 1999). Jones (1999) stated that the site is an impressive product of a dedicated teaching group, who have whole-heartedly embraced the versatility of on-line teaching and also indicated that the pedagogy had been carefully considered in the design of the site. Jones also highlighted comments made by students in the discussion forum (which gave insights into their experiences of the learning process) as an example of the value of well-designed electronic learning materials. Fyfe (1999) felt that the strengths of the site are the Self-Assessment Modules, the CyberTutor facility and the discussion lists and was pleased to see the amount of course content discussion between students.

In April 2000 a survey was sent by email to 400 of 1300 students (all students are provided with a free email address by the University) regarding their access to computer resources, and their perceptions and usage of the VLE. The response rate was 25%. It is appreciated that the results may be slightly biased towards students who take the trouble to use the email provided. Of those students 98% had used the VLE, 94% were connected to the Internet at home but only 68% had loaded the required plug-in Shockwave for Authorware on their machines. Of those students who had used the VLE, all of them had accessed the lecture notes whilst less than 45% accessed other material such as computer-based learning modules, self-test answers etc. Use of modules is probably related to the requirement for Shockwave. Most students (82%) found the site easy to navigate. This data can be compared to a 1999 paper-based survey indicating 93% of students had used the on-line resources room with 81% accessing it from home.

From a technical point of view, 16% of students have found accessing our materials frustrating this year, as most of the CAL requires the plug-in Shockwave

for Authorware, which has increased in complexity and download time, causing problems for students. To address this extensive download time we are providing students CD-ROMs with Shockwave, to facilitate their access to our materials.

We have also come to realise that due to increased usage of the Internet in homes for business, pleasure, research for school projects and for access to the VLE, our students may be experiencing difficulties in their households competing with other users of the Internet and the available telephone lines. A recent survey indicates that 37% of students using the Internet at home report competition for its use. We will consider offering a CD-ROM later this year with all the CAL modules, thus giving students better access to our learning resources whilst leaving the communications side of the VLE dependent on the Internet.

Conclusion

We have provided resources for students that we believe are helping them in their learning. The careful use of technology is enhancing their opportunities to gain access to course materials and to self-assess their learning outcomes. We are currently researching the effectiveness of the use of various learning resources, including the IT components and our findings will help drive curriculum re-design.

For the science graduates of tomorrow we are providing exciting learning experiences that will help develop the skills of problem-solving, critical thinking, self-assessment and life-long learning.

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